



Causes of Environmental Pollution in China's Yangtze River Basin and Corresponding Ecological Compensation Measures

Nan Chen

Anhui Broadcasting Movie and Television College, Hefei, Anhui, 210000, China

Corresponding author: Nan Chen

Nat. Env. & Poll. Tech.
Website: www.neptjournal.com

Received: 12-12-2016

Accepted: 17-01-2017

Key Words:

Yangtze River Basin
Environmental Pollution
Ecological Compensation

ABSTRACT

Construction of numerous water conservancy and hydropower engineering and migration projects, increased regional population, and accelerated urbanization have seriously polluted the ecological environment of the Yangtze River Basin and upset coordinated development economy, society, and ecological environments. This study comprehensively analyses the ecological environment status of the Yangtze River Basin, explores causes of the regional environmental pollution, and provides countermeasures to improve the regional ecological environment through ecological compensation. Results suggest that construction of a large number of water conservancy projects, large-scale project-caused migration, extensive economic growth mode, and adoption of imbalanced development policies are the most important causes of environmental pollution in China's Yangtze River Basin. The ecological environment of the Yangtze River Basin can be improved in the following aspects: improving the government's transfer payment from the exchequer system and expanding the ecological compensation fund-raising channels; improving the environmental resource ownership system and actively developing the emission trading market; improving the legal system and strengthening government supervision; and vigorously developing environmentally-friendly industries and techniques, and sharpening the public's awareness of ecological compensation. All these findings can provide referential experiences for promoting coordinated ecological and economic development, and improving the ecological compensation mechanism in the Yangtze River Basin.

INTRODUCTION

The Yangtze River of 6,300 km in full length is the longest river in China. The river drains 18% of China's land area, and its basin is home to 37% of the country's population. The Yangtze River Basin is one of China's strategically significant economic belts, and it covers East China, Central China, and West China. However, the rapid development of the regional economy, explosive growth of the regional population, and exhaustion of the regional environmental resources have created the pressure of environmental pollution and threatened the ecological environment seriously in the Yangtze River Basin. The mutual influence of natural, economic, and social factors has worsened the ecological environment of the Yangtze River Basin as marked by vegetable deterioration and aggravation of water and soil loss. The ecological environment protection, improvement, and construction of the Yangtze River Basin cannot be ignored owing to its significant geographical and strategic position. Therefore, this study analyses the ecological economy status of the Yangtze River Basin and causes of its environmental pollution. For this purpose, specific approaches are proposed to address environmental pollution in the Yangtze River Basin through ecological

compensation by referring to practical experiences and models of different countries in treating the basin environmental pollution through ecological compensation.

EARLIER STUDIES

The concept of "ecological compensation" originated from foreign scholars' research and practices of ecological service value. Thus, ecological compensation is also known as payment for ecological system services. Ecological compensation research has existed in the western academic field for a long time. Previous research has focused on behaviour and choices of microcosmic bodies in ecological compensation and obtained the following findings.

Cuperus defined ecological compensation as a kind of compensation for damage of ecological functions and quality during the development process; the aim is to improve the environmental quality or create areas with similar ecological functions and environmental quality for the pollution-stricken areas (Cuperus et al. 1996). Sowman proposed a set of ecological economy simulator and designed multiple ecological compensation plans to protect biological diversity using ecological and economic methods (Sowman et al. 1995). Pagiola emphasized that impoverished areas

are the main targets of ecological compensation (Pagiola et al. 2005). On the basis of sustainable development theories, Pagiola suggested that ecological compensation cannot only accelerate development and poverty relief of the poverty-stricken areas but also fuel the local ecological protection and investment. Falk tried different design concepts, confirmed the inter-regional horizontal transfer payment, highlighted lack of trust of the upper and middle reaches on payment mechanism of the lower reaches, and proposed regional integration to transfer capitals to the upper reaches and to promote government's ecological protection of the upper reaches (Falk & Kosfeld 2006). Kosoy studied the basic ecological compensation practices in three Latin American countries, namely, Honduras, Costa Rica, and Nicaragua (Kosoy et al. 2007). Wunscher mentioned that failure of considering heterogeneity of the project participants will influence efficiency of the ecological compensation; otherwise, inclusion of the opportunity cost of project participants and direct protection cost into the project choices will significantly promote the ecological compensation efficiency (Wunscher et al. 2008). Wunder compared and analysed 13 typical ecological compensation cases in different countries (Wunder et al. 2008). Chen also found that inclusion of the opportunity cost can enable efficient ecological compensation (Chen et al. 2010). Cranford proposed a two-period compensation method targeted at individuals and communities (Cranford & Mourato 2011). Brown introduced a unified and reliable decision-making framework that considers ecological compensation practices (Brown et al. 2013). Schomers demonstrated that most ecological compensation projects in developed and developing countries are sponsored by government (Schomers & Matzdorf 2013). Home argued that incentives should be provided to encourage farmers to implement ecological compensation measures during farmland ecological protection (Home et al. 2014). Qu proposed establishment of the ecological compensation charge, taxation, and foundation system to protect the ecological environment of Chinese seas (Qu et al. 2016).

The above mentioned research findings on ecological compensation show that the concept and plans of ecological compensation has gained wide attention from the entire society. Foreign scholars have focused on fairness of compensation for ecological product providers, and the compensation amount is based mainly on the willingness of the compensated. Different evaluation methods for different types are available, and comprehensive evaluation can be obtained using the dynamic model. The scholars also considered economic, social, and environmental factors. This way improves the evaluation efficiency and balances the interests of different parties. Therefore, this study analyses

causes of environmental pollution in China's Yangtze River Basin and proposes major ecological compensation measures. The results reveal that establishment of the ecological and political values, improvement of the government's ecological responsibility mechanism, strengthening of the ecological value education, stimulation of public participation, and improvement of the market compensation mechanism can efficiently curb the environmental pollution in the Yangtze River Basin.

CAUSES OF ENVIRONMENTAL POLLUTION IN THE YANGTZE RIVER BASIN

Construction of numerous water conservancy and hydropower projects: Construction of numerous water conservancy and hydropower projects, particularly large-scale ones, has significantly influenced the climate and surroundings of the basin area. First, impoundment of water conservancy and hydropower projects forms a spacious water surface, which accelerates evaporation and increases humidity of the surrounding areas. In summer, the water surface temperature is lower than the air temperature. The atmospheric convection is thus weakened and the precipitation is decreased. However, in winter, the water surface temperature is higher than the air temperature. Strengthening of atmospheric convection significantly increases precipitation and changes its temporal and spatial distribution as well. Consequently, droughts, floods, and other extreme weather become frequent. Second, geological disasters, such as landslides and debris flows, can be triggered. The reason is that the water level increases after impoundment, thereby soaking stones or soil on two banks in water and decreasing their hardness. When heavy rains occur, the loose stones and soil may slide easily. Third, water conservancy and hydropower projects are characterized by a long construction period, complex construction procedures, and large excavated volume of cubic meters of earth and stones. The excavated aggregated rocks are often stocked outdoor without any cover. Heavy rainfalls may move sediments directly into the watercourse, such that sedimentation and lifting of the riverbed occurs. Moreover, the watercourse may be blocked to cause cutoff, impede the shipping business, and even influence the flood control. Water conservancy and hydropower projects on the upper reaches of the Yangtze River are located in a complex topography. Many geomorphic types, including mountains, hills, and plains, exist, such that the transportation is inconvenient in the area. In particular, a series of preparations prior to construction, such as road pavements and clearing of the construction site, may damage the surface vegetation and increase the bare area of the ground. As the anti-erosion capability of the land weakens, rainstorms will cause serious water and

soil loss because the concentration of rainstorm points in the upper reaches of the Yangtze River. Therefore, construction of a large number of water conservancy and hydropower projects in the upper reaches of the Yangtze River has seriously influenced the ecological environment, society, and economy of the entire basin. Worsening of ecological environment of the upper reaches has become a major cause of the widening gap of economic development between the upper and lower reaches. This condition also justifies the ecological compensation offered by the lower reaches to the upper reaches in the Yangtze River Basin.

Large-scale project-induced migration: Water conservancy and hydropower projects play an important role in flood control, power generation, irrigation, water supply, and ecology, as well as social and economic development. However, water conservancy and hydropower projects often force a large number of local people to resettle. The serious environmental problems thus caused have seriously affected production, life, social, and economic development of the migration area.

Meanwhile, project-induced migrants may cause ecological damage, such as water and soil loss. Project-induced migration includes not only farmers but also towns, markets, industrial enterprises, and specialized projects. A large flow of project-induced migrants have aggravated the local water and soil loss. In particular, migration causes water and soil loss because of three main reasons. First, the migration-planned area is unreasonable. Ecological environmental factors of the resettlement areas are not fully considered, and analytical demonstration of environmental capacity is not comprehensive. Most often, only the number of resettlement migrants is considered, whereas the bearing capacity of the environment is ignored. Thus, the population is extremely concentrated in the resettlement area, thereby causing exhaustion of the local environmental resources. Second, the resettlement work lacks guidance of an ecological concept. During the migration process, various infrastructures, including residences and transportations, need to be set up in the planned area. The planned area is expanded to hold a large migration population, such that different degrees of damage of landforms are induced. As the surface vegetation areas shrink, the surface soil loosens, thus reducing the water and soil retention capability of the land, increasing the soil looseness, and triggering water and soil loss. Third, the living environment of migrants is worsening. Most water conservancy and hydropower projects are located in poverty-stricken mountainous areas, and migrants are engaged mainly in agricultural production. However, these water conservancy and hydropower projects occupy most arable lands. Lands are reclaimed to provide a living

to the resettled, and the resettled have to move to a higher elevation. The increasing reclamation of slope croplands has resulted in worsening desertification.

Extensive economic growth mode: Many industries have existed in the Yangtze River Basin for a long time. In the upper reaches of the Yangtze River Basin, heavy-pollution enterprises, such as papermaking and chemical enterprises, have turned the area into a serious pollution belt. In recent years, pollution caused by industrial production of the Yangtze River Basin has been efficiently curbed. However, some areas are still facing worsening pollution. Under the extensive economic growth mode, fund support lacks for ecological treatment and protection. The government has to solve the environmental problem by expanding the economic scale and accelerating the development speed. A series of blind investments has decreased the efficiency of enterprises and the project quality. The heavy-pollution and high-energy-consumption economic growth mode still exists in the upper reaches of the Yangtze River Basin. The energy consumption of coal, petroleum, natural gases, and water electricity is extremely high. The unit GDP (Gross Domestic Product) energy consumption is higher than the average national level. The industrial wastewater discharge index caused by the unit GDP is high and above the average national level. The energy utilization rate is lower than that of the average national level. Operation of the high-cost economic system deprives most enterprises in the upper reaches of the Yangtze River Basin of the capability on environmental treatment and ecological protection. Without adequate funds for environmental protection and treatment, the upper reaches of the Yangtze River are faced with increasing environmental debts. This condition not only accelerates worsening of the regional ecology but also results in a vicious circle of extensive growth. The unreasonable resource allocation and the inefficient resource utilization cannot be changed in a short term. The disunity between development speed and effects, development quantity and quality, and economic development and ecological protection forces the local government to keep on expanding at a fast speed. Inevitably, "repeated construction" is facilitated, which leads to a new round of extensive growth and the vicious cycle of ecology and economy.

Non-balanced development strategy: China has adopted the non-balanced development strategy since the early period of its reform and opening-up. The widening economic and social gap between the lower and upper reaches still persists. According to the non-balanced strategy, coastal areas in the lower reaches of the Yangtze River enjoyed the priority of development. After the development reached certain level, capitals and techniques would be introduced

to the upper reaches of the Yangtze River to achieve joint development. However, in the 1990s, the development trend was contrary to that supposed by the non-balanced strategy in the lower and upper reaches of the Yangtze River Basin. The lower reaches indeed achieved economic prosperity, but the economic prosperity did not spread to the upper reaches. Large amounts of energy resources were sold to the lower reaches at an extremely low market price. After processing, they were sold to the upper reaches at a high price. The inequivalent exchange against the market rule resulted in losses of the upper reaches. Intervened by the national power, the upper reaches slowed down their development and exhausted the resources for the lower reaches to push the lower reaches into the rich period first. The rapid industrial development of lower reaches seriously weakened the economic development position of the upper reaches. The goal of “early and later prosperity” was half realized. The prosperity was not achieved in the upper reaches. Currently, the economic gap still keeps widening. Without adequate funds and techniques, the upper reaches cannot effectively balance their ecological protection and economic development.

ECOLOGICAL COMPENSATION MEASURES OF ENVIRONMENTAL POLLUTION

Improve the government’s transfer payment from the exchequer system and broaden the fund-raising channels for ecological compensation: A scientific and reasonable transfer payment from the exchequer system is an important guarantee to realize equalization of inter-regional public services; this approach is the most direct and easiest among others for ecological compensation. In the future, the amount of various funds for ecological compensation should be gradually increased, and the government’s transfer payment from the exchequer system should be gradually improved. Specifically, the amount of transfer payment from the exchequer should be increased first. The tax returns should be reduced to include the institutional subsidies and the settlement subsidies into the general transfer payment from the exchequer system. In this way, the general transfer payment from the exchequer is no longer mainly targeted at solving the local financial operation difficulties but is used to promote equalization of public services. Second, the weight of environmental factors should be increased in the transfer payment from the exchequer. Much support should be given to the ecologically vulnerable areas and the major ecological protection areas. According to the principle of equal public services, substantial transfer payment from the exchequer should be allocated to Central and West China. The important ecological areas (such as natural reserves) and ecological elements are purchased by the country. An

efficient long-term mechanism should be established to boost economic development of the critical ecological construction areas, improve living standards of farmers and herdsmen, and realize regional sustainable economic and social development. Third, the ecological compensation financing modes should be innovated to achieve financing marketization. The entrepreneurship investment funds or risk investment funds for ecological environmental protection should be available to provide direct capital support for enterprises not yet listed. This concept is equivalent to the securities investment fund and belongs to the scope of direct investment. Pooling idle social assets serves as equity investment of emerging enterprises with a large development potential, and provides a series of value-added services for funded enterprises. High returns on investment can be obtained through equity transactions. Intervention of the entrepreneurship investment funds can not only realize combination of the environmental industries and the capital market, fund ecological enterprises, and solve the problem of inadequate ecological construction capitals but also results in quality-listed enterprises for the securities market. Fourth, the ecological capital market should be fostered and developed. In the modern economy, the fund-raising function of the capital market becomes increasingly obvious. Providing full play to functions of the capital market is a focus of fund-support ecological environmental protection and construction.

Improve the environmental resource property rights system and actively foster the emission trading market: Definition of the environmental resource ownership relies on the initial distribution of the environment and resource rights. The ownership, use right and right to earnings of the environment and resources can be defined as privately owned. The country should unify the utilization of public ecological environments and resources with high consumption and emission cost to avoid unnecessary waste or abuse, and protect social interests from being damaged. The government can formulate standards based on the self-purifying capability of the ecological system and the threshold concentration for resource exploitation, use, pollution and damage. The government should also decompose the resource and environment ownership on behalf of the country. For example, the resource and environment rights can be divided into resource permit, management, franchise, and development rights. These decomposed environmental rights can be initially distributed among market players. Legal bases should be available to clarify subjects responsible for the ownership of natural resources, such as minerals, lands, waters, and forests. However, survival quality resources, such as air and water quality, are difficult to define. Powerful measures and institutions should be developed to

achieve efficient, transparent, and standard monitoring and management. The initial distribution plan of the emission right should be clarified, and the unpaid distribution mode in the past should be eliminated. Auction, offer for sale, and other special processing modes can be adopted to promote fair competition among enterprises. The market service information should be immediately updated. The unreasonable pricing system should be efficiently adjusted to maintain the market order, promote internalization, and play a positive role in creating the market transaction mechanism and compensating the market failure. Professional emission right trading agencies and relevant information network systems should be established to increase transparency of transaction information and cut the emission right transaction cost. Relevant government departments should formulate incentive mechanisms to support enterprises that cut emission and actively sell the emission right in terms of capitals, taxes, and techniques. If emission enterprises become bankrupt or are merged, then the government should encourage the emission rights to be a part of the bankruptcy or merging process. As to newly increased emission enterprises, they can purchase general emission rights through market transactions.

Improve the legal system and strengthen the government supervision: The legal system should be improved in accordance with the ecological construction and protection objectives, and clauses out of line with the practical requirements should be amended. Punishment for environmental pollution behaviour should be tightened, while the environmental emission standards should be upgraded. Unreasonable pollutant emission standards should be modified, and construction and management standards of the ecological functional areas should be developed. As an amendment to the environmental protection laws, the pollution emission information disclosure mechanism should be legalized such that the public can be provided with environmental protection information. The government should strengthen its monitoring role in the following aspects. First, laws and regulations concerning security, environmental protection, quality, and labour protection for producers and law enforcers should be improved. Second, the project approval system with social monitoring at the core should be provided to enhance monitoring and fully internalize the environmental cost. Referring to management experiences of the China Securities Regulatory Commission, the China Banking Regulatory Commission, the China Insurance Regulatory Commission, and the China Technique Regulatory Commission, the government can build a vertical environmental management mechanism, enhance independence of the local environmental management institutions, and avoid government intervention in environmental pro-

tection. Institutional reform is necessary because fundamentally changing the economic development strategies and growth modes is difficult.

Vigorously develop the environmental industries and techniques, and sharpen the public awareness of ecological compensation: In deepening the market mechanism of the pollution governance, the system of “who treats, who benefits” should be established to encourage professional enterprises to concentrate on coping with pollution. The practice of polluters paying for their pollution is an important fundamental condition to deepen the market mechanism. The charge standards for pollution should be unified to achieve the goal of keeping profits while covering the compensation. The environmental institutions should undergo enterprization reform. Development and industrialization of environmental techniques can improve competitiveness of environmental enterprises. The environmental enterprises and products should be certified by the third party according to international practices. Environmental hazards appearing during the industrialization process of developed countries and environmental pollution of various Asian countries in their rapid-development period suggest that the world still lacks techniques in line with its economic development. The global issues of environmental protection should be the focus of research. The traditional process should be transformed; especially the closed-loop, hazard-free, and clean process should be actively developed. Science popularization of ecological compensation can sharpen the public awareness of ecological compensation and spread the ecological compensation policies. The public will actively participate in ecological compensation. Communities are the final targets of the ecological compensation mechanism. Awareness, cognition, and willingness of the community dwellers can directly influence the ecological compensation effects. The government should encourage community members to actively participate in the process of formulating and planning the ecological compensation mechanism. Especially in the impoverished areas, international or domestic projects should be launched to enhance capability construction of local government departments and community organizations and develop decision makers, planners, management personnel, and corporate managers among the public. Based on the monitoring role of the public, loans can be combined with enterprise listing and environmental protection through information disclosure. The monitoring role of communities should also be considered such that enterprises can be encouraged to meet emission standards.

CONCLUSIONS

The Yangtze River Basin plays an important role in the

sustainable development of China's economy and ecology. However, the rapid economic development of the basin area has aggravated the ecological damage. With less vegetable and worsening soil and water loss, a series of disasters threatening the local ecological safety has emerged. Overall, the ecological environment of the Yangtze River Basin is worsening. This study mainly analyses the ecological environmental status of the Yangtze River Basin, summarizes specific causes of the environmental pollution, and finally proposes countermeasures to handle the environmental pollution through ecological compensation. The results suggest that construction of numerous water conservancy and hydropower projects, large-scale project-induced migration, extensive economic growth mode, and national non-balanced development strategy are the major causes of the environmental pollution in China's Yangtze River Basin. The environmental pollution in the Yangtze River Basin can be addressed through ecological compensation in four aspects, including improving the government's transfer payment from the exchequer system and expanding the ecological compensation fund-raising channels; improving the environmental resource ownership system and actively developing the emission trading market; improving the legal system and strengthening government supervision; and vigorously developing environmentally friendly industries and techniques, and sharpening the public's awareness of ecological compensation. This research is limited in that the focus is only on analysing specific causes of the environmental pollution of the Yangtze River Basin. The research can be extended by covering economic losses of the lower, middle, and upper reaches brought by environmental pollution, the ecological compensation operation mechanism, and different approaches of ecological compensation in different provinces, and establishment of the government-dominated ecological compensation mechanism.

ACKNOWLEDGEMENT

This work was supported by Key research project of Humanities and Social Sciences in Universities of Anhui Prov-

ince in 2015 "Study on the core competitiveness of Binhu wetland Forest Park in Hefei based on the ecological perspective" (sk2015A606).

REFERENCES

- Brown, M.A., Clarkson, B.D. and Barton, B. J. et al. 2013. Ecological compensation: an evaluation of regulatory compliance in New Zealand. *Impact Assessment and Project Appraisal*, 31(1): 34-44.
- Chen, X., Lupi, F. and Vina, A. et al. 2010. Using Cost Effective Targeting to Enhance the Efficiency of Conservation Investments in Payments for Ecosystem Services. *Conservation Biology*, 24(6): 1469-1478.
- Cranford, M. and Mourato, S. 2011. Community conservation and a two-stage approach to payments for ecosystem services. *Ecological Economics*, 71(1): 89-98.
- Cuperus, R., Canters, K. J. and Piepers, A. A. G. 1996. Ecological compensation of the impacts of a road. Preliminary method for the A50 road link (Eindhoven-Oss, The Netherlands). *Ecological Engineering*, 7(4): 327-349.
- Falk, A. and Kosfeld, M. 2006. The hidden costs of control. *The American Economic Review*, 96(5): 1611-1630.
- Home, R., Balmer, O. and Jahrl, I. et al. 2014. Motivations for implementation of ecological compensation areas on Swiss lowland farms. *Journal of Rural Studies*, 34(2): 26-36.
- Kosoy, N., Martinez-Tuna, M. and Muradian, R. et al. 2007. Payments for environmental services in watersheds: Insights from a comparative study of three cases in Central America. *Ecological Economics*, 61(2): 446-455.
- Pagiola, S., Arcenas, A. and Platais, G. 2005. Can payments for environmental services help reduce poverty? An exploration of the issues and the evidence to date from Latin America. *World Development*, 33(2): 237-253.
- Qu, Q., Tsai, S.B. and Tang, M. et al. 2016. Marine ecological environment management based on ecological compensation mechanisms. *Sustainability*, 8(12): 1267.
- Schomers, S. and Matzdorf, B. 2013. Payments for ecosystem services: A review and comparison of developing and industrialized countries. *Ecosystem Services*, 6(12): 16-30.
- Sowman, M., Fuggle, R. and Preston, G. 1995. A review of the evolution of environmental evaluation procedures in South Africa. *Environmental Impact Assessment Review*, 15(1): 45-67.
- Wunder, S., Engel, S. and Pagiola, S. 2008. Taking stock: A comparative analysis of payments for environmental services programs in developed and developing countries. *Ecological Economics*, 65(4): 834-852.
- Wunscher, T., Engel, S. and Wunder, S. 2008. Spatial targeting of payments for environmental services: a tool for boosting conservation benefits. *Ecological Economics*, 65(4): 822-833.